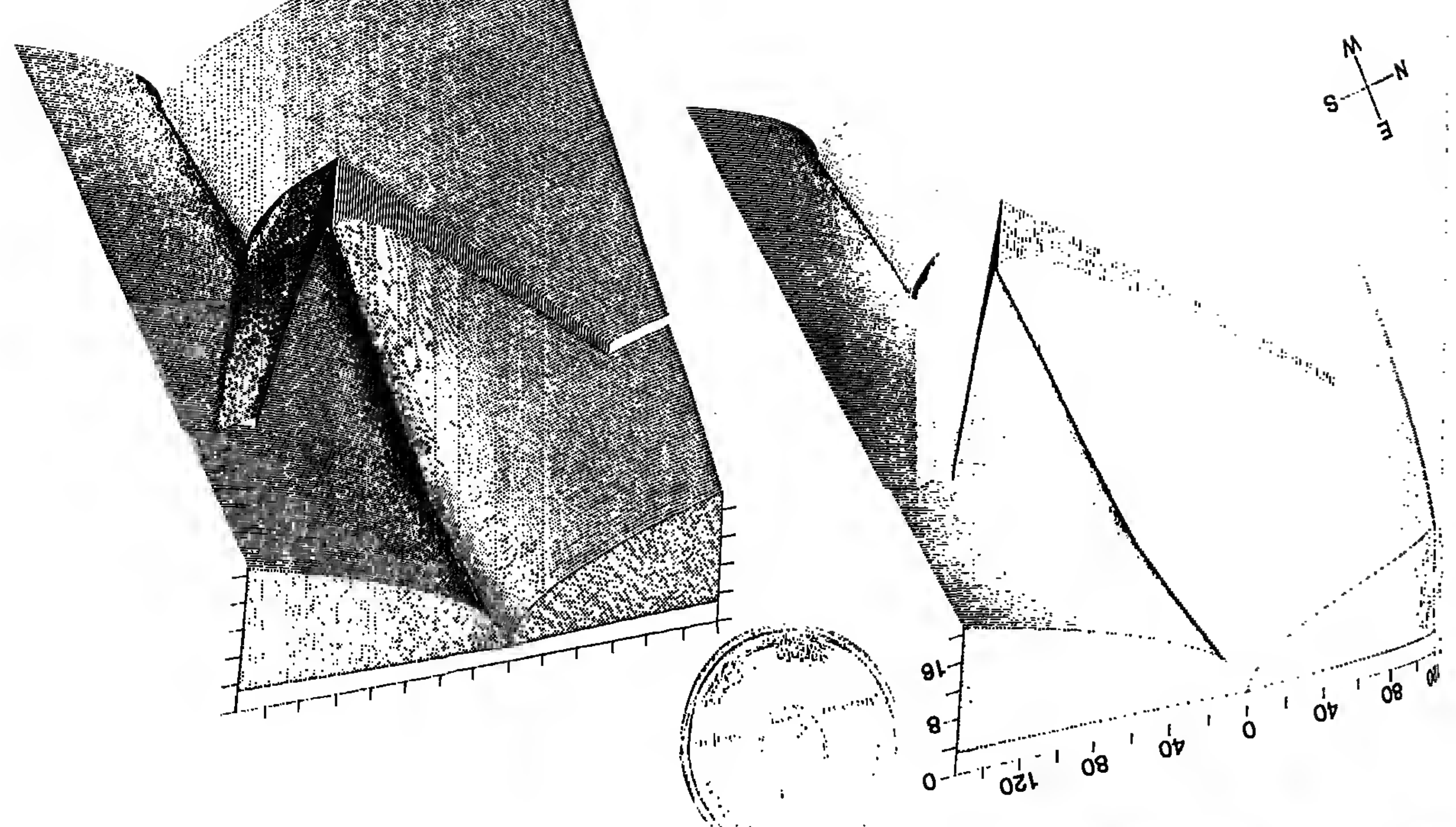

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News

Synchrotron Uses

The geological and materials sciences have a number of common interests and interfaces, according to a report recently issued by the National Academy Press. Entitled *Fostering Increased Cooperation Between the Geological and Material Sciences*, the report provides a relatively low-key comparison of areas of common ground between the two sciences; it identifies no major issues of disagreement and thus has no axes to grind. Instead, the report is a short, soft-sell discussion of the burgeoning revolutions taking place in the more applied sectors of the geological and condensed matter or solid-state sciences. The material sciences are receiving a wealth of experience with highly complex mineralogical and geological materials and advances in the applications of analytical techniques that had been originated by solid-state scientists for the study of metals and single compounds. In turn, the earth sciences are receiving new techniques and theories from the material sciences.

According to the report, both fields of applied science need better lines of intercommunication to foster more effective interaction. An example of this need is noted in the report; it centers on the common requirement of both the geological and the material sciences for a higher intensity energy source than is now available to advance the analysis of condensed matter. Synchrotron radiation sources appear to be central in meeting this requirement.

It is noteworthy that in another study by the National Academy of Sciences, the so-called 'Lynch Report' of the Solid-State Sciences Committee (*Physics Today*, February 1983), it was concluded that, 'By 1985, . . . demand for x-ray and UV (synchrotron) beams will exceed the additional supply that would be available if unused ports on current machines were developed.' Synchrotron facilities at Stanford University, the University of Wisconsin, Cornell University, and at Brookhaven National Laboratory are being constructed or modified to meet the needs of new, exciting, materials analysis research. Originally only a side advantage that was relatively unused in synchrotron facilities, the high intensity white radiation released as a secondary product in the acceleration of electrons has now taken precedence over the particle-physics experiments for which the facilities were constructed. Rather special instrumentation is needed to exploit the 'free' white radiation, and new generations of synchrotrons are being planned for the purpose.

In older, 'first generation' synchrotrons the primary electron beam is held in a circular path by means of dipole magnets placed in precise locations along the accelerator ring. The intensity of the high-energy beam of radiation that is released as the electrons are accelerated around a circular path can be increased by several orders of magnitude by new concepts of magnetic-field insertion devices that are called 'wigglers' or 'undulators.' These devices have a large number of weak dipoles or a smaller number of strong dipoles. Depending on the design, high intensity beams of broad or narrow wavelength spectra can be created. A number of problems with these devices, such as overheating caused by the large energy densities, have yet to be solved. The insertion devices are mostly still in the design and construction stages, awaiting testing. Research areas noted in the Lynch Report are SEXAFS (surface X ray absorption fine structure), X ray diffraction and scattering, and photoemission spectroscopy. The sort of problems to be investigated with these ultra-high-intensity beams include the study of short-time (nanosecond) phenomena, two-dimensional structures, and surface physics. The relatively unexplored field of megabar high-pressure experiments may yield a wealth of new materials that are amenable to study by synchrotron radiation beams.

Of relevance to the renewed interest in the study of materials properties is the recent news of the new National Center for Advanced Materials (NCAM) proposed as a major new direction for the Lawrence Berkeley Laboratory in California. According to one report, the planned laboratory 'comes with a strong endorsement from White House science advisor George Kenworth, and it is a centerpiece of the proposed 1984 budget for the Department of Energy (DOE) general sciences program.' (*Nature*, February 10, 1983). In another recent report it is noted that, 'A synchrotron radiation light source is the centerpiece for the National Center for Advanced Materials at the Lawrence Berkeley Laboratory' (*Science*, February 18, 1983). The costs to DOE for NCAM will be a total of $283.8 million, of which $138.9 million would be for construction of facilities. The new, third-generation synchrotron will take 6 years to build, at a cost of $84 million. As a subset, $13.8 million is to be allocated to the Stanford University Synchrotron Radiation Laboratory to experiment with the problems of unusually intense X ray beams.

The NCAM will include three laboratories, one for Surface Science and Catalysis, one for Advanced Material Synthesis, and one for Advanced Device Concepts. Perhaps most interesting to the geology-materials science interface is the Advanced Materials Synthesis Laboratory in which theoretical and experimental studies will be done of phase transitions and materials at high pressures. Central to the three laboratories missions will be the new-generation synchrotron Advanced Light Source (ALS), which is to produce a beam brightness (energy density per unit area) some 10^4 times greater than existing sources. According to the designers, 'The brightness of the synchrotron radiation from the ALS will not be entirely due to the use of insertion devices. Another important feature, reports *Science*, is the storing of a circulating electron beam (1.3 billion eV) with a very small emittance.' The new light source will overcome problems of beam stability inherent in the older accelerators by focusing to a stable point source.

The National Academy report of the Committee on Geological and Materials Sciences noted that the number of people working on geological materials was less, by one or two factors of ten, than the number working in the materials sciences. Federal agencies, it was noted, spent over $1 billion on materials R&D in 1980. Geologists have had notable successes in the fields of extractive metallurgy and other materials sciences areas; according to the report, examples in which information has flowed to, rather than, as in so many other cases, from the materials sciences include phase equilibrium, isotope and trace element analysis, major element analysis by the electron microprobe, and high-pressure, high-temperature research.—*PMB*

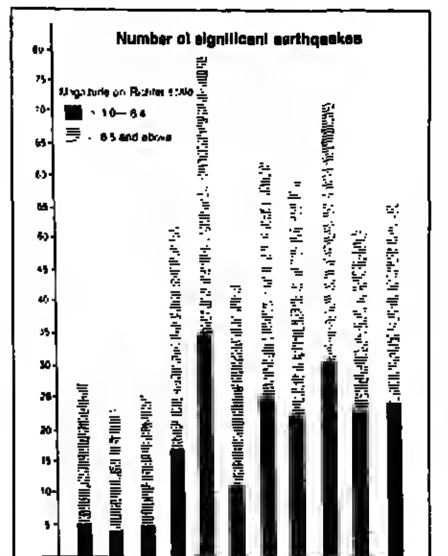
Earthquakes Up Worldwide in 1982

Fifty-six 'significant earthquakes' were recorded in 1982, up from the 1981 tally of 51, according to a recent report from the U.S. Geological Survey (USGS). In addition, in the United States there were 33 more 'felt' earthquakes in 1982 than in 1981. The number of lives lost worldwide to earthquakes, however, dropped by one-third. A significant earthquake is defined as one that registers 6.5 or above on the Richter scale or one of smaller magnitude that causes casualties or considerable damage. Felt earthquakes are nonsignificant quakes that are reported as being felt by people. The data are compiled by the USGS from 3,000 seismograph stations around the world.

In the United States in 1982 only one significant earthquake occurred, striking on January 25; this was the lowest number recorded since 1974, when none occurred. The 1982 event registered 6.5 and was centered in the Fox Islands in the Aleutians; there were no reports of casualties or damages.

The strongest earthquake of 1982, measured at 7.7, hit the Tonga Islands region of the South Pacific on December 19 without causing damage or casualties, according to Waverly Person, a geophysicist at the USGS National Earthquake Information Service. It was among a total of 10 major earthquakes (registering 7.0 to 7.9) recorded worldwide. For the second consecutive year no great earthquakes (registering 8.0 or more) occurred; the last such event was a magnitude 8.0 quake recorded on July 17, 1980, in the Santa Cruz Islands region of the South Pacific. The long-term average of earthquakes of magnitude 7.0 and over is 19 per year.

The most devastating earthquake of 1982 occurred in North Yemen, located on the Arabian Peninsula. Registering a magnitude of 6.0, it killed 2,800 people, injured another 1,500, left more than 700,000 homeless, and destroyed or extensively damaged 300 villages. The second deadliest jolted the Hindu Kush region of Afghanistan with a magnitude 6.5. Reported deaths totalled 450, with many others injured. The zone of damage stretched into Tajikistan in the Soviet Union. In addition, a magnitude 7.0 quake that struck El Salvador in Central America on June 19 claimed 40 lives.



Significant earthquakes throughout the world. A significant earthquake is defined as one that registers 6.5 or above on the Richter scale or one of smaller magnitude that causes casualties or considerable damage. The smallest significant earthquake occurring in the period charted above measured 4.2. Data courtesy of USGS; data charted by Mario E. Godinez; chart drafted by Dae Sung Kim.

Person said the known death toll from earthquakes in 1982 was 3,338, about one-third fewer people than were reported killed in 1981; most of the deaths in 1981 are attributed to two strong quakes that hit Iran. On the long-term average, 10,000 earthquake-related deaths are expected each year. Notably, no earthquake-related deaths have been reported in the United States since 1975.

In 1982, the USGS received 404 reports of felt earthquakes in the United States. The strongest to occur in the conterminous 48 states was a magnitude 5.5 tremor that rumbled along the California-Nevada border south of Hawthorne, Nev., and southeast of Mono Lake, Calif., on September 24.

Once again, Hawaii led other states with 137 felt earthquakes, followed by California with 108 and Alaska with 44. The other states reporting felt quakes and the number of reports for each were Arkansas 14; Idaho 11; Nevada 10, Maine 8; New Hampshire 7; Connecticut, New Mexico, and Washington 6 each; Vermont 5; Massachusetts and Montana 4 each; Arizona, Colorado, Georgia, Tennessee, and Texas 3 each; Alabama, New York, South Carolina, South Dakota, and Utah 2 each; and Iowa, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, North Carolina, Oklahoma, and Pennsylvania 1 each.

Person said the USGS normally records between 6,000 and 7,000 earthquakes worldwide each year that range in magnitude from 3 to 8 or more on the Richter scale. Several million more earthquakes may occur, he said, but most are so small or happen in such remote areas that they are not detected even by the most sensitive instruments in the worldwide seismograph network.—*MEG*

Salton Sea Minerals

The long-held notion that precious metals, minerals, and other useful substances can be extracted from natural waters is starting to become realized at several locations of geothermal brines. In a recent study by A. Maimoni of the Lawrence Livermore National Laboratory it was determined that there is a high potential for minerals recovery from the hot brines of a 1000-MWe geothermal power station at the Salton Sea geothermal field in southern California. The study estimated that the revenue from the minerals could substantially exceed that from the power station (*Geothermics, 11*, 239–258, 1982).

According to the study, 'A 1000-MWe power plant could recover 14-31% of the U.S. demand for manganese.' In the example of lithium production, such a geothermal plant could produce 5–10 times the annual world output of lithium. Large quantities of lead and zinc could be extracted, as well as significant amounts of gold, platinum, and silver. The chemical composition of the brines is incredibly complex, however, for reasons not currently understood.

In pilot-plant studies at the Salton Sea, there have been numerous difficulties related to the precipitation of silica, corrosion, and other factors, and thus new recovery techniques will be required. The Lawrence Livermore study suggests that a chemical cementation process, in which metallic iron is used to cause precipitation of dissolved metals, may be the most economical.

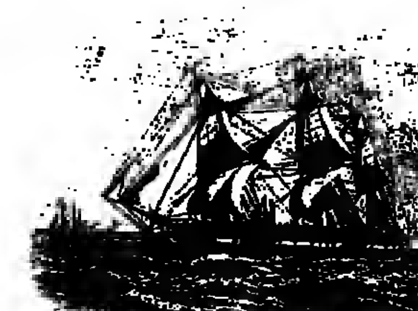
In the cementation extraction technique, spent brines are processed through a metallurgical recovery system, and then the brine is reinjected. At the well head, finely divided iron is introduced into the brine to act as a nucleation source for the precipitation of sulfides and precious metals. Hydrochloric acid is added to the brines as they are passed through fluidized beds and various separation stages.

Silica control is absolutely necessary in the metal extraction process. The deposition of silica-rich scale is substantial during any equipment operation involving the brines, and indeed scale has been a major negative factor in the development of geothermal energy in the Salton Sea area. Among other examples, the Magmamax No. 1 well in the area had recorded scaling rates as high as 0.002 m/h. The scales contain much more than silica, however; a 3-month test sample, in which 5–7 tonnes of scale were collected, contained approximately 20% copper plus a concentration of precious metals amounting to several kilograms of silver and about 0.003 kg of gold per tonne.

In the Lawrence Livermore study, scale was reduced by addition of hydrochloric acid to lower the pH to a value of about 1.5. Suspended solids in the brines could be reduced to zero, but steel corrosion rates were of concern. Corrosion rates vary with location, pH, temperature, and other factors. Testing showed that the rates of corrosion were not greatly harmful, however, ranging from a few thousandths to a few hundredths of a centimeter per year in steel pipe specimens.

The outline of a successful geothermal power and minerals recovery plant in the Salton Sea area is as follows. The plant would operate 75% of the time for a total of 6570 operating hours per year. A 90% recovery rate for the mineral values in the brines was estimated before the brines were re-injected into the ground. The power plant would yield a net power of 22 Wh/kg of brine, corresponding to a brine flow rate of 45 million kg/h. At six cents per kilowatt-hour, the power plant value would amount to $394 million per year. The estimated recovery would involve 48 tonnes per year of SiO_2, 11 tonnes per year of NH_3, 28 tonnes per year of Si, 136 tonnes per year of Mn, 102 tonnes per year of Fe, and lesser amounts of Zn, Sn, Pb, Se, Ag, Au, and Pt. These estimates are not highly accurate, considering the variability of the brines, but they indicate a real potential.—*PMB*

The Oceanography Report



H.M.S. CHALLENGER [illegible], 1874.

The Oceanography Report
The focal point for physical, chemical, geological, and biological oceanographers.

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Distribution of Elements in Sea Water

M. S. Quinby-Hunt and K. K. Turekian

The purpose of this report is to provide a basis for predicting the composition of elements at any depth or location in the world oceans. Our aim is not to assess the importance of variations in elemental concentrations but only to provide a method of estimating them. The method, however, provides no entry into the problem of estimating the effects of local releases from sediments or of human activity.

The salinity of the open ocean ranges between 33‰ and 38‰. *Dittmar* [1884] showed that despite this variation in total salt concentration the proportions of the different ions making up most of the salt content were remarkably constant. In that sense these ions are identified as being 'conservative'; that is, their variation is ascribed exclusively to the addition or subtraction of pure water to a saline solution of fixed elemental proportions. The concentrations of certain trace elements also have been shown to correlate with chlorinity within analytical errors and these too can be classified as behaving conservatively.

It was early realized, by noting the distribution of high productivity regions of the ocean, that certain elements (phosphorus, nitrogen, and silicon) are not conservative; surface waters are generally depleted in these elements and deep waters have higher concentrations than overlying surface waters. These are called the 'nutrient' elements. Any other element behaving in a similar way could also be so designated. The fact that the distribution of certain trace elements might resemble that of the nutrients was not easily demonstrable until a few years ago because of analytical limitations. There were, however, intimations of this relationship [*Schutz and Turekian*, 1965*a*, *b*], and the concept was proposed as reasonable, although with no clear examples, by *Goldberg et al.* [1971]. It was finally demonstrated for Sr [*Brass and Turekian*, 1974] and Cd [*Knauer and Martin*, 1973] and has since been a well-established observation for many trace elements.

The dissolved gases have a much more complex distribution. Initially, the levels are determined by the solubility of atmospheric gases in surface water and by bubble trapping. In principle the concentration of each gaseous component could be determined by the temperature of the water in contact with the atmosphere and the measured relative abundances of the gases in the atmosphere, although corrections must be made for bubble trapping. Supersaturation can occur with heating of the water as it sinks and moves away from the site of a cold surface injection. A much more marked effect is observed for biologically processed gases which change in concentration as the result of metabolism. Thus oxygen is produced by photosynthesis in surface water and used up during net respiration at depth. Other gases similarly affected to some degree are N_2, CO_2, N_2O, H_2S, H_2 and CO.

The open ocean has been impacted by man's activities. This is clearly seen by the presence of bomb-produced nuclides such as ^{90}Sr, ^{137}Cs, ^{3}H, ^{14}C(bomb) and plutonium. In addition, at least one element, Pb, has been clearly shown to owe its distribution to anthropogenic inputs. The distribution of these nuclides in the ocean is controlled by supply from the atmosphere and from coastal sources, thus generally showing patterns of diminishing concentration with depth.

Fluxes of some nuclides from the ocean boundaries can significantly modify the distribution pattern of these nuclides. The most striking of these is primitive ^3He degassing from the earth's interior at oceanic spreading centers [*Craig and Lupton*, 1981]. It has been shown that Mn correlates with ^3He in such areas [*Weiss*, 1977]. Manganese concentrations are also high at shallow depths near the continental margin, indicating release from reducing sediments there [*Landing and Bruland*, 1980]. Copper is released from the deep ocean bottom by the degradation of carrier phases at the interface [*Boyle et al.*, 1977].

Finally, removal processes characteristic of the ocean–bottom interface such as particle resuspension and manganese precipitation also influence the distribution patterns of the elements. This influence has been shown for ^{210}Pb produced from the decay of ^{226}Ra [*Craig et al.*, 1974; *Nozaki et al.*, 1980] but has not yet been demonstrated for the trace metals in the deep sea.

All the above relationships act to determine the element composition of seawater as a function of location and depth. Aside from the elements showing strong boundary effects or those with strong anthropogenic signals, the distribution patterns for trace elements are approximated by (1) behavior as a conservative element or (2) behavior as a nutrient element. We have reviewed the literature reporting distributions of elements in seawater and the correlations they exhibit with conservative or nutrient components. We have assigned some elements to a correlation category based on the data available, although detailed profiles have not been published.

Table 1 includes the reported behavior of each element. For conservative elements, the relation to chlorinity (Cl) is reported. For nutrient-correlated elements the correlation equation and the correlation coefficients are given. Table 2 summarizes the best available data on the concentrations of the elements in seawater (in order of atomic number). Data have been published in a variety of units; here, concentrations of elements other than nutrients and gases are expressed as milligrams per kilogram, micrograms per kilogram, or nanograms per kilogram depending on the concentration. The nutrients and gases are given as micromoles per kilogram. In Table 2, surface or near-surface concentrations and a concentration near 1000 m in the Pacific Ocean are reported where possible. A mean ocean concentration has been calculated where possible using correlation expressions found in Table 1, a salinity of 35‰, and nitrate, phosphate, and silicate concentrations of 30, 2, and 110 μmol/kg (based on *Bainbridge* [1979a, b, c]), respectively.

The concentrations of some of the members of the ^{238}U, ^{235}U, and ^{232}Th decay chains (^{234}Th, ^{234}U, ^{230}Th, ^{226}Ra, ^{222}Rn, ^{210}Pb, ^{210}Po, ^{231}Pa, ^{228}Ra, ^{228}Th) have been extensively studied recently, in large part as a consequence of the GEOSECS program and its successors. Most of the papers dealing with the distributions of these radionuclides are published in *Earth and Planetary Science Letters*, *Deep-Sea Research*, and *Journal of Geophysical Research*.

TABLE 1. [illegible]

Atomic Number	Element	Species	Behavior	[illegible]	[illegible]	Reference
1	Hydrogen	H_2	[illegible]			
2	Helium		[illegible]			
3	Lithium		[illegible]			
4	Beryllium		[illegible]	[illegible]		[illegible]
5	Boron	Inorganic boron	Conservative	[illegible]		[illegible]
6	Carbon	ΣCO_2	Nutrient			
7	Nitrogen	N_2	Non-nutrient gas			
		Nitrate	Nutrient			
8	Oxygen	Dissolved O_2	[illegible]			
9	Fluorine		Conservative	[illegible]		
10	Neon		Non-nutrient gas			
11	Sodium		Conservative	[illegible]		[illegible]
12	Magnesium		Conservative	[illegible]		[illegible]
13	Aluminum					[illegible]
14	Silicon	Silicate	Nutrient			
15	Phosphorus	Phosphate	Nutrient			
16	Sulfur	Sulfate	Conservative	[illegible]		
17	Chlorine	Chloride	Conservative	[illegible]		[illegible]
18	Argon		Non-nutrient gas			
19	Potassium		Conservative	[illegible]		
20	Calcium		Correlated with carbonate alkalinity; 1st approximation conservative	[illegible]	[illegible]	[illegible]
21	Scandium					
22	Titanium					
23	Vanadium		Conservative	[illegible]		[illegible]
24	Chromium		Nutrient correlated silicate and phosphate or nitrate	[illegible]	[illegible]	[illegible]
25	Manganese		Surface maximum at depth [illegible]			[illegible]
26	Iron		Correlated with the nutrients [illegible]			[illegible]
27	Cobalt		Similar to manganese			[illegible]
28	Nickel		Nutrient correlated phosphate and silicate	[illegible]	[illegible]	[illegible]
29	Copper		Scavenged [illegible]			[illegible]
30	Zinc		Nutrient correlated silicate	[illegible]	[illegible]	[illegible]
31	Gallium					
32	Germanium		Nutrient correlated silicate	[illegible]	[illegible]	[illegible]
33	Arsenic	As(V)	Nutrient correlated, phosphate			[illegible]
34	Selenium	[Se(IV)]	Nutrient correlated silicate, phosphate	[illegible]	[illegible]	[illegible]
		[Se(VI)]		[illegible]		
		[Se(VI)]		[illegible]		
35	Bromine	Bromide	Conservative	[illegible]		[illegible]
36	Krypton		Non-nutrient gas			
37	Rubidium		Conservative	[illegible]		[illegible]
38	Strontium		Nutrient correlated, phosphate	[illegible]	[illegible]	[illegible]
39	Yttrium		1st approximation conservative	[illegible]		
40	Zirconium					
41	Niobium					
42	Molybdenum		Conservative	[illegible]		[illegible]
44	Ruthenium					
45	Rhodium					
46	Palladium					
47	Silver					
48	Cadmium		Nutrient correlated, phosphate	[illegible]	[illegible]	[illegible]
49	Indium					
50	Tin		Nonconservative, anthropogenic			[illegible]
51	Antimony		Conservative	[illegible]		[illegible]
52	Tellurium					
53	Iodine	Iodate	Nutrient correlated, nitrate, phosphate	[illegible]	[illegible]	[illegible]
54	Xenon		Non-nutrient gas			
55	Cesium		Conservative	[illegible]		[illegible]
56	Barium		Nutrient-correlated, silicate, alkalinity	[illegible]	[illegible]	[illegible]
57–71	Lanthanum and the Lanthanides		Nutrient or depth correlated			[illegible]
72	Hafnium					
73	Tantalum					
74	Tungsten					
75	Rhenium					
76	Osmium					
77	Iridium					
78	Platinum					
79	Gold					
80	Mercury		Nutrient-correlated, silicate	[illegible]	[illegible]	[illegible]
81	Thallium		Conservative			[illegible]
82	Lead		Non conservative, anthropogenic			[illegible]
83	Bismuth					
84	Polonium		See text			
85	(Astatine)					
86	Radon		See text			
87	(Francium)					
88	Radium		See text			
89	Actinium					
90	Thorium					
91	Protactinium					
92	Uranium		Conservative	[illegible]		Turekian and Chan [1971]

The relationship to chlorinity is mass to mass. S is salinity. Nutrient concentrations are in micromoles per kilogram.

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TABLE 2. Observed Elemental Concentrations in Sea Water and Predicted Mean Oceanic Concentrations

Atomic Number	Element	Species	Surface Concentration (Sample Depth)	Deep Water Concentration (Sample Depth)	Predicted Mean Water Concentration	Profile Available	References
1	Hydrogen	H_2					
2	Helium		1.7 nmol/kg (2 m)	1.9 nmol/kg (927 m)	1.0 nmol/kg	x	*Clarke et al.* [1970]
3	Lithium		178 μg/kg (2 m)	c	178 μg/kg	x	*Fabricand et al.* [1967]
4	Beryllium		36 pg/kg (40 m)	144 pg/kg (700 m)	0.2 ng/kg	x	*Measures and Edmond* [1982]
5	Boron	Inorganic Boron	4.4 mg/kg	c	4.4 mg/kg	x	*Noakes and Hood* [1961]
6	Carbon	ΣCO_2	2030 μmol/kg (1 m)	2261 μmol/kg (714 m)	2200 μmol/kg	x	*Broecker and Takahashi* [1978]
7	Nitrogen	N_2		560 μmol/kg (905 m)	590 μmol/kg	x	*Craig et al.* [1967]
		NO_3	0 μmol/kg (22 m)	41 μmol/kg (891 m)	30 μmol/kg	x	*Bainbridge* [1979a]
8	Oxygen	Dissolved O_2	205 μmol/kg (1.7 ml/l) (22 m)	17 μmol/kg (1.1 ml/l) (891 m)	150 μmol/kg	x	*Bainbridge* [1979a]
9	Fluorine		1.3 mg/kg	c	1.3 mg/kg	x	*Bewers et al.* [1973]
10	Neon		7.0 nmol/kg (10 m)	8.0 nmol/kg (1086 m)	8 nmol/kg	x	*Craig et al.* [1967]
11	Sodium		10.781 g/kg	c	10.781 g/kg	x	*Millero and Leung* [1976]
12	Magnesium		1.284 g/kg	c	1.28 g/kg	x	*Carpenter and Manella* [1973]
13	Aluminum		1.0 μg/kg (0 m)	0.4* μg/kg (1000 m)	1 μg/kg	x	*Hydes* [1979]
14	Silicon	Silicate	2.0 μmol/kg (22 m)	180.0 μmol/kg (891 m)	110 μmol/kg	x	*Bainbridge* [1979a]
15	Phosphorus	Reactive phosphate	0.08 μmol/kg (22 m)	2.84 μmol/kg (891 m)	2 μmol/kg	x	*Bainbridge* [1979a]
16	Sulfur	Sulfate	2.712 g/kg	c	2.712 g/kg	x	*Morris and Riley* [1966]
17	Chlorine	Chloride	19.353 g/kg	c	19.353 g/kg	x	*Wilson* [1975], *Millero and Leung* [1976]
18	Argon		10.0 μmol/kg (10 m)	15.6 μmol/kg (1000 m)	15.6 μmol/kg	x	*Craig et al.* [1967]
19	Potassium		399 mg/kg	c	399 mg/kg	x	*Culkin and Cox* [1966]
20	Calcium		417.6 mg/kg (50 m)	418.6 mg/kg (1000 m)	415 mg/kg ([illegible]) 412 mg/kg ([illegible])	x	*Horibe et al.* [1974]
21	Scandium		0.4–1.0 ng/kg (all depths)		<1 ng/kg	x	*Brewer et al.* [1972]
22	Titanium		4.0 μg/kg		<1 μg/kg		*Griel and Robinson* [1952]
23	Vanadium		1.0 μg/kg (0 m)	1.2* μg/kg (1000 m)	<1 μg/kg	x	*Morris* [1975]
24	Chromium	[illegible]	268 ng/kg (0 m)	290 ng/kg (1000 m)	330 ng/kg (vs. [illegible]) 190 ng/kg (vs. PO_4) 150 ng/kg (vs. SiO_2)	x	*Cranston* [1979]
25	Manganese	Dissolved Mn	31 ng/kg ([illegible] m)	36 ng/kg (985 m)	10 ng/kg	.	*Landing and Bruland* [1980]
26	Iron		5 ng/kg (0 m)	15 ng/kg	10 ng/kg	x	*Gordon et al.* [1982]
27	Cobalt		7 ng/kg (0.2 m)	2 ng/kg (900 m)	2 ng/kg	x	*Knauer et al.* [1982]
28	Nickel		140 ng/kg (0 m)	560 ng/kg (985 m)	480 ng/kg	x	*Bruland* [1980]
29	Copper		41 ng/kg (0 m)	140 ng/kg (985 m)	120 ng/kg		*Bruland* [1980]
30	Zinc		6–7 ng/kg (0 m)	458 ng/kg (985 m)	390 ng/kg	x	*Bruland* [1980]
31	Gallium		15–30 ng/kg		10–20 ng/kg		*Burton et al.* [1959], *Ishibashi et al.* [1961]
32	Germanium		<0.5 ng/kg (0 m)	6 ng/kg (1000 m)	5 ng/kg	x	*Froelich and Andreae* [1981]
33	Arsenic	As(V)	1.1 μg/kg (0 m)	1.0 μg/kg (1000 m)	2 μg/kg	x	*Andreae* [1979]
		Dimethylarsenate	0.1 μg/kg (1 m)			x	[illegible] [1979]
34	Selenium	[illegible]	[illegible]	[illegible]	[illegible]	x	*Measures and Burton* [1980]
		[Se IV]	<2 ng/kg (1 m)	20 ng/kg (732 m)	—	x	
		[Se VI]	25 ng/kg (1 m)	65 ng/kg (732 m)	—	x	
35	Bromine	Bromide	67 mg/kg	c	67 mg/kg	x	*Morris and Riley* [1966]
36	Krypton		2.0 nmol/kg (10 m)	3.7 nmol/kg (900 m)	3.7 nmol/kg	x	*Bieri et al.* [1968]
37	Rubidium		124 μg/kg (10 m)	c	124 μg/kg	x	*Spencer et al.* [1970]
38	Strontium		7.401 mg/kg (10 m)	7.720 mg/kg (700 m)	7.8 mg/kg (PO_4) 7.7 mg/kg ([illegible])	x	*Brass and Turekian* [1974]
39	Yttrium			13 ng/kg (deep water)	13 ng/kg		*Hogdahl et al.* [1968]
40	Zirconium		~1 μg/kg (0 m)		<1 μg/kg		*Sastry et al.* [1969]
41	Niobium		<10 ng/kg (0 m)		1 ng/kg		*Carlisle and Hummerstone* [1958]
42	Molybdenum		11 μg/kg (0 m)	c	11 μg/kg	x	*Morris* [1975]
44	Ruthenium		0.7 ng/kg (10 m)	0.5* ng/kg (980 m)	0.5 ng/kg	x	*Dixon et al.* [1966]
45	Rhodium						
46	Palladium						
47	Silver			3* ng/kg (1100 m)	3 ng/kg	x	*Schutz and Turekian* [1965b]
48	Cadmium		0.8 ng/kg (0 m)	117 ng/kg (985 m)	70 ng/kg	x	*Bruland* [1980]
49	Indium		0.3 ng/kg (2 m)	0.1* ng/kg (1000 m)	0.2 ng/kg	x	*Matthews and Riley* [1970]
50	Tin		1.0 ng/kg (0 m)		0.5 ng/kg		*Byrd and Andreae* [1982]
51	Antimony		0.2 μg/kg	0.2 μg/kg	0.2 μg/kg	c	*Brewer et al.* [1972]
52	Tellurium						
53	Iodine		48 μg/kg (2 m)	60* μg/kg (1018 m)	50 μg/kg (PO_4 corr.) 60 μg/kg (NO_3 corr.)	x	*Wong and Brewer* [1974]
54	Xenon		0.28 nmol/kg (10 m)		0.5 nmol/kg	x	*Mazor et al.* [1964]
55	Cesium		0.3 μg/kg (0 m)	c	0.3 μg/kg	x	*Spencer et al.* [1970]
56	Barium		4.8 μg/kg (15 m)	13.5 μg/kg (997 m)	11.7 μg/kg	x	*Chan et al.* [1976]
57	Lanthanum		1.80 ng/kg (100 m)	3.50* ng/kg (700 m)	4 ng/kg	x	*Elderfield and Greaves* [1982]
58	Cerium		2.35 ng/kg (100 m)	5.46* ng/kg (700 m)	4 ng/kg	x	*Elderfield and Greaves* [1982]
59	Praseodymium			0.6* ng/kg (deep)	0.6 ng/kg		*Hogdahl et al.* [1968]
60	Neodymium		1.85 ng/kg (100 m)	3.04* ng/kg (700 m)	4 ng/kg	x	*Elderfield and Greaves* [1982]
61	Promethium						
62	Samarium		0.46 ng/kg (100 m)	0.65* ng/kg (900 m)	0.6 ng/kg	x	*Elderfield and Greaves* [1982]
63	Europium		0.10 ng/kg (100 m)	0.15* ng/kg (900 m)	0.1 ng/kg	x	*Elderfield and Greaves* [1982]
64	Gadolinium		0.54 ng/kg (100 m)	0.88* ng/kg (900 m)	0.8 ng/kg	x	*Elderfield and Greaves* [1982]
65	Terbium			0.1* ng/kg (deep)	0.1 ng/kg		*Hogdahl et al.* [1968]
66	Dysprosium		0.78 ng/kg (100 m)	0.81 ng/kg (900 m)	1 ng/kg	x	*Elderfield and Greaves* [1982]
67	Holmium			0.2* ng/kg (deep)	0.2 ng/kg		*Hogdahl et al.* [1968]
68	Erbium		0.8 ng/kg (100 m)	0.83* ng/kg (900 m)	0.9 ng/kg	x	*Elderfield and Greaves* [1982]
69	Thulium			0.2* ng/kg (deep)	0.2 ng/kg	x	*Hogdahl et al.* [1968]
70	Ytterbium		0.61 ng/kg (100 m)	0.81* ng/kg (900 m)	0.8 ng/kg	x	*Elderfield and Greaves* [1982]
71	Lutetium			0.2* ng/kg (deep)	0.2 ng/kg		*Hogdahl et al.* [1968]
72	Hafnium		<8 ng/kg		<8 ng/kg		*Schutz and Turekian* [1965a]
73	Tantalum		<2.5 ng/kg		<2.5 ng/kg		*Schutz and Turekian* [1965a]
74	Tungsten		[illegible] μg/kg		<1 ng/kg		*Ishibashi* [1953], *Chan and Riley* [1967]
75	Rhenium		5.0 ng/kg (0 m)	4.5* ng/kg (900 m)	4 ng/kg		*Olafsson and Riley* [1972]
76	Osmium						
77	Iridium		0.1				
78	Platinum						
79	Gold		4–27 ng/kg (all depths)		11 ng/kg		*Schutz and Turekian* [1965a]
80	Mercury		5 ng/kg (above thermocline)	4* ng/kg (1000 m)	8 ng/kg	x	*Mukherji and Kester* [1979]
81	Thallium		11–15 ng/kg (0 m)		12 ng/kg	.	[A. R. Flegal, pers. comm., 1980]
82	Lead		13.6 ng/kg (0.2 m)	4.5 ng/kg (1000 m)	1 ng/kg	x	*Schaule and Patterson* [1981]
83	Bismuth		20 ng/kg (0 m)		10 ng/kg		*Brooks* [1960]
84	Polonium						
86	Radon						
88	Radium						
89	Actinium						
90	Thorium		<0.7 ng/kg		<0.7 ng/kg		*Kaufman* [1969]
91	Protactinium						
92	Uranium		3.2 μg/kg	c	3.2 μg/kg	x	*Turekian and Chan* [1971]

Deep water concentration data are for comparison only. Where possible they are from the Pacific Ocean, which usually shows the greatest concentration difference; otherwise they are from the Atlantic. The letter c indicates that concentrations of conservative elements have been normalized to 35 ‰.
*Atlantic Ocean deep water data.

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Cover. An equal-area map of the world with edges formed by major tectonic plate boundaries. This tectonic plate map prepared by Athelstan Spilhaus allows comparison of plate areas and also preserves plate shapes. It is constructed from four aspects of a transverse Mollweide projection joining at the north pole. The four aspects have centers at the equator at 60°W, 160°W, 120°E, and 20°E.

News & Announcements

Bird Demise Tied to El Niño

The first massive disappearance of a total bird population from a tropical atoll has been credited to the 1982 El Niño.

Roughly 17 million seabirds—virtually the entire adult bird population on Christmas Island in the mid Pacific—either perished or fled, leaving behind thousands of nestlings to starve, according to a report from the National Science Foundation. Among those birds that either abandoned the world's largest coral atoll or died are 14 million sooty terns, at least 1.5 million wedge-tailed shearwaters, and 1 million birds comprising 16 other species.

Ralph W. Schreiber, curator of ornithology at the Natural History Museum of Los Angeles County in California, said he believes that the El Niño may have disrupted the ecological food chain by cutting off nutrients upwelling from the ocean depths. These nutrients sustain the fish and squid that are the birds' only food supply. When the flow of ocean nutrients shifted, the fish and squid sought an area richer in nutrients, leaving the Christmas Island birds to their plight. Schreiber has studied birds and mammals in the central Pacific Ocean for more than 15 years.

El Niños, recurring on an average of every 7 years, are anomalies in the interaction of the atmosphere and the oceans and include a warming of the upper ocean and a weakening of the trade winds. This ocean warming may be a response to a relaxation of the winds in the western or central Pacific Ocean, although other hypotheses have been advanced. In addition to previously documented and devastating effects of the El Niño on the marine food chain, the anomaly has been tied to warmer than normal winters in eastern North America.

'What has happened [on Christmas Island] was a real shock and a catastrophe when put in the context of the breeding biology of these species,' Schreiber said. He learned in November of the birds' disappearance and demise when he visited the atoll; he is uncertain of the exact departure date of the birds.

Schreiber hopes to discern when, or if, the birds will return to the island, what reproductive cycles they will reestablish, and what their diet and reproductive success will be during recovery.

Christmas Island, just north of the equator, was discovered on Christmas Eve in 1777 by the English navigator Captain James Cook. It is now part of the Republic of Kiribati.

Oceanography (cont. on p. 132)

Oceanography *(cont. from p. 131)*

Pacific Warm Event

A preliminary description of the 1982 equatorial warm event was published in February as a special issue of the *Tropical Ocean–Atmosphere Newsletter*. A followup special issue is planned to discuss the equatorial Pacific environment during the first 6 months of 1983.

The newsletter is published bimonthly by the University of Washington's Joint Institute for the Study of the Atmosphere and Ocean (JISAO), with support from the Equatorial Pacific Ocean Climate Studies (EPOCS) program within the National Oceanic and Atmospheric Administration. For additional information, contact David Halpern, JISAO, University of Washington, AK-40, Seattle, WA 98195.

Opinion

Bottom Water

I read with great interest your writeup on the 'Mysteries of Bottom Water' in the March issue of The Oceanography Report (*Eos*, March 1, 1983, p. 85).

I can recall the time, not so very long ago, when some very prominent physical oceanographers dismissed the notion advanced by paleo-oceanographers that the deep ocean environment is far from steady. It is nice to see them come around, some of them even to start to pay attention to what paleo-oceanographers have to say.

Delmar Schmitker
Woods Hole Oceanographic Institution
Woods Hole, Mass.

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Postdoctoral Position in Solar-Terrestrial Physics. The Center for Atmospheric and Space Sciences of Utah State University has a postdoctoral position in solar-terrestrial physics. The position is for one year but has renewable opportunities. The recipient is expected to develop theoretical models to describe the large-scale flow of plasma in the terrestrial ionosphere and magnetosphere and to study the stability of the flow. Candidates should have a Ph.D. and a background in space physics and/or plasma physics. Send letter of application, resume, and the names and addresses of two references by April 30 to Professor N. W. Schunk, Center for Atmospheric and Space Sciences, Utah State University, Logan, Utah 84322 [801-750-2074].
Utah State University is an Affirmative Action/Equal Opportunity employer.

Oregon State University/Faculty Position. The Department of Geology invites applications for a tenure-track position in geophysics at rank of assistant professor beginning fall, 1983. The position is supported at 50% level by the department to teach two courses, introductory and exploration geophysics. The successful applicant would need to provide up to 50% salary support from research grants or other sources. Ability to maintain an active, externally-funded research program involving students and ability as a classroom teacher of geology students are important considerations. Send resume, transcripts, and statement of teaching and research interests to Robert S. Yeats, Chairman, Dept. of Geology, OSU, Corvallis, OR 97331—5506. List at least 3 references to whom the committee may write. Application deadline May 15, 1983. OSU is an Affirmative Action/Equal Opportunity Employer and complies with Section 504 of the Rehabilitation Act of 1973.

Research Position/Space Physics. The Space Physics and Astronomy Department at Rice University seeks applicants for one or more full-time research positions within the department. Successful applicant(s) will play key role(s) in the development of theoretical three-dimensional models of the Earth's electromagnetic field. Applicants should have knowledge of, and interest in, at least one of the following areas: solar-wind magnetosphere interactions, magnetosphere-ionosphere coupling, ionosphere-atmosphere coupling, atmospheric electricity. Experience and/or interest in numerical modeling is an important consideration.
Title and salary level commensurate with experience, ranging from one-year Research Associateship (renewable in subsequent years depending on performance) to open-ended Research Scientist appointment in the Center for Space Physics. Please send resume and names of three professional references to T. W. Hill or R. A. Wolf, Space Physics and Astronomy Department, Rice University, Houston, TX 77251.
The University is an equal opportunity/affirmative action employer.

Atmospheric Sciences/Research Assistant, Oregon State University. Applications are invited for a position as Research Assistant which is expected to be available in the Climatic Research Institute, Oregon State University, beginning in May 1983. This position involves assistance in the production and analysis of computer simulations with large numerical models of the atmosphere and ocean, and requires a basic familiarity with atmospheric modeling, data analysis techniques, and programming. Salary within the range $18,000—$22,000 will depend upon qualifications and experience. Interested candidates possessing a M.S. degree in atmospheric or computer science are invited to submit an application with a summary of their experience and the names of two professional references to Dr. W. L. Gates, Director, Climatic Research Institute, Oregon State University, Corvallis, Oregon 97331 before 2 May 1983.
Oregon State University is an Affirmative Action/Equal Opportunity Employer and complies with Section 504 of the Rehabilitation Act of 1973.

Research Positions for Mathematical Physicists. Applications are invited for several research positions at the Center for Studies of Nonlinear Dynamics, La Jolla Institute, beginning summer 1983. Current research involves work on nonlinear wave-wave interactions, acoustic, optical, and radio wave propagation in random media, and fluctuation phenomena in the statistical mechanics of chemical and geophysical systems. Physicists and applied mathematicians who are interested in working on problems of the above type should send resumes and arrange for three letters of recommendation to be sent to Dr. Stanley Flatte, Director, CSNO, La Jolla Institute, 8950 Villa La Jolla Drive, Suite 2150, La Jolla, California 92037.
La Jolla Institute is an equal opportunity/affirmative action employer.

Atmospheric Chemist/University of Michigan. The Department of Atmospheric and Oceanic Science invites applications for a tenure track position in Atmospheric Chemistry to begin January 1984. Successful applicant must have a demonstrated commitment to excellence in teaching and experimental research. A joint appointment with the Department of Chemistry has been a tradition of this position and is expected to continue. Responsibilities will include teaching atmospheric chemistry at the undergraduate and graduate level, development of relevant curriculum, and directing a high quality independent experimental research program. Faculty rank and salary commensurate with qualifications. Send resume, statement of research interests and the names of four references before July 1, 1983 to: G. R. Carignan, Director, Space Physics Research Laboratory, Department of Atmospheric and Oceanic Science, University of Michigan, 2455 Hayward, Ann Arbor, MI 48109.
The University of Michigan is an Equal Opportunity/Affirmative Action Employer.

Postdoctoral Position in Physical Oceanography. A postdoctoral appointment in physical oceanography will be available beginning September, 1983 in the College of Marine Studies, University of Delaware, Newark, Delaware. The initial appointment will be for one year with probable extension for a second year. The salary will be $20,000-$24,000 per year, depending on experience. Funds for the position will be available largely from a grant by NSF for conduct and analysis of a field oceanographic study of the shelfbreak front in the Middle Atlantic Bight.
The person obtaining the appointment would be responsible for a portion of the planning and execution of the field study, much of the subsequent data analysis and interpretation, and teaching of one graduate level course in physical oceanography each year. The successful applicant must have received the Ph.D. in physical oceanography or a closely related field by the starting date of his appointment. Preference will be given to applicants with direct experience in field observations.
To apply send a complete resume and the names of three references to Professor R. W. Garvine, College of Marine Studies, University of Delaware, Newark, DE 19711. (Telephone: (302) 738-2169).
The University of Delaware is an equal opportunity/affirmative action employer.

Hydrogeologist. Applications are invited for a hydrogeologist—engineering geologist position starting in January 1984. Rank and salary are dependent on qualifications and experience. Ph.D. degree and registration as a professional engineer desirable.

Responsibilities will include undergraduate and graduate teaching and graduate research in hydrogeology and engineering geology. Applicants should have experience in field groundwater investigations of regional site specific nature/groundwater resource analyses/waste disposal/groundwater contamination studies. Experience in applying remote sensing to hydrogeology and engineering studies would be helpful.

Send resume and names of three references to J. J. Finney, Head, Geology Department, Colorado School of Mines, Golden, Colorado 80401. Applications will be accepted until September 15, 1983. The Colorado School of Mines is an affirmative action/equal opportunity employer.

Assistant Research Oceanographer Position. The Center for Coastal Studies, Scripps Institution of Oceanography, has an opening for a physical oceanographer with a general background in nearshore processes with emphasis on field and remote sensing investigations of surface gravity waves.

Incumbent will be expected to conduct field and remote sensing experiments of wave properties, dynamics and climatology in the nearshore environment. Responsibilities will also include design and implementation of surface gravity wave measurements supporting a variety of other nearshore processes investigations.

Minimum qualifications for this position are the Ph.D. degree in oceanography and a demonstrated publication record. Successful candidate should have previous field experience as well as demonstrated expertise in wave propagation theory, array design and data adaptive directional spectrum estimation theory. High levels of skill in oral and written communication are necessary.

Appointment in the University of California system is for 1 or 2 years (renewable) and will be at the Assistant Research I, II, or III level, salary from $22,900-$25,200, commensurate with qualifications. Submit resume, indicating an interest in this specific position together with a minimum of three references, before 4 May 1983, to:

H. L. Inman, Director, Center for Coastal Studies
A-009, Scripps Institution of Oceanography
University of California-San Diego
La Jolla, CA 92093.

SIO/UCSD is an Equal Opportunity/Affirmative Action Employer.

Faculty Position/Physical Oceanography, University of Maryland Center for Environmental and Estuarine Studies (UMCEES). The Horn Point Environmental Laboratories of UMCEES invite applications for a tenure-track (rank open) position for a physical oceanographer. The physical oceanographic program is young and developing, so that candidates with a wide range of research interests will be considered. Opportunities exist for oceanographers with experimental, theoretical, or numerical modeling skills. In addition, the strong chemical and biological programs provide opportunities for interdisciplinary research. Although some preference will be given to applicants with interests in continental shelf and estuarine circulation processes, the primary criterion for selection of the successful candidate is the ability to develop a strong research program. The closing date for applications is May 16, 1983. Applications and a list of references should be sent to:

Dr. William C. Boicourt
Chairman, Search Committee
University of Maryland
Center for Environmental and
Estuarine Studies
Horn Point Environmental Laboratories
P. O. Box 775
Cambridge, Maryland 21613.

The University of Maryland is an Affirmative Action/Equal Opportunity Employer.

Statistician (Scientist II)/National Center for Atmospheric Research. To work as a scientist/statistician in a multidisciplinary group conducting studies of environmental societal impact of atmospheric processes and carry out independent research program in statistical meteorology and related areas. Requirements include Ph.D. in statistics or mathematics or equivalent skill in applying quantitative techniques such as multiple regression analysis, time series modeling and decision analysis to problems in the atmospheric sciences, demonstrated publications record, and commitment to work in multidisciplinary research projects. Skill in computer programming (FORTRAN) and familiarity with statistical computing techniques as well as statistical software packages desired. A scientist II position is for a non-renewable term of up to four years. Individual may then be appointed to scientist III in accordance with UCAR policy. Position will be available on or about October 1983. To apply contact: Margareta Domecki, 303-494-5151 or send resume and list of publications to: NCAR, Employment, P. O. Box 3000, Boulder, Colorado 80307.

An equal opportunity/affirmative action employer.

Staff Scientists/Systems Analysts. Research and Data Systems, Inc. has openings available for Staff Scientists, Systems Analysts and Programmer/Analysts to work in areas involved in the processing and application of data from satellite based remote sensing systems. Particular needs involve the analysis and processing of Earth Radiation Budget, Microwave, AVHRR and LANDSAT data. Needs also exist in the areas of interactive image graphics, software engineering, realtime processing and satellite data communications. Successful candidates will have an advanced degree in meteorology, physics, engineering, mathematics, or computer science. Hardware background should include IBM, DEC, CYBER or HP-1000 equipment. Send resume in confidence to:

Research and Data Systems, Inc.
10300 Greenbelt Road, Suite 206
Lanham, Maryland 20706
Telephone: (301) 390-6100.

Igneous or Metamorphic Petrology. The Department of Geology seeks to fill a tenure track position in petrology beginning either August 15, 1983 or January 1, 1984. Appointment will be at the rank of assistant professor. Post-doctoral experience is considered important. The successful candidate will be expected to develop an aggressive research program, teach both graduate (Ph.D., MS) and undergraduate levels and interact with an active group of faculty and students in mineralogy, petrology and geochemistry. Research facilities in the department include: automated electron microprobe, solid-source mass spectrometer, gas-source mass spectrometer, SEM, AA, non-automated XRF, and Harris 800 computer. Please send a resume, a statement of research interests and the names of at least three references to: Chairman, Petrology Search Committee, Department of Geology, Northern Illinois University, Dekalb, Illinois 60115.

Application deadline is May 1, 1983, although search will continue until position is filled.

Northern Illinois University is an equal opportunity/affirmative action employer.

Earthquake Engineering/Geosciences. The Lawrence Livermore National Laboratory, located in the San Francisco Bay area, has a permanent opening at the MS or Ph.D. level in engineering geosciences. Emphasis of present projects in the field of earthquake risk analysis and requires knowledge of earth sciences, geotechniques, probabilities, and computer programming. Because of the rather large spectrum of projects undertaken in the Geosciences Group, the preferred candidate will have a broad background in engineering.

Salary is commensurate with degree and experience. Please send resume to: H.L. Betancourt, LAWRENCE LIVERMORE NATIONAL LABORATORY, P.O. Box 808, L-95, KFS-403, Livermore, CA 94550, and/or call 415-422-0307, 422-0768 or 423-0196. U.S. citizenship is required.

LLNL is an equal opportunity employer M/F/H/V.

SERVICES, SUPPLIES, COURSES, AND ANNOUNCEMENTS

Calderas and Hydrothermal Systems. Held in Yellowstone National Park, August 22–27, 1983. College credit available. For more information, contact: THE YELLOWSTONE INSTITUTE, Box 515, Yellowstone National Park, WY 82190. (406) 443-0861.

AGU membership application continued from preceding page

CATEGORY – Check category for which you are applying.

(M) ☐ MEMBER
Individuals professionally engaged in or associated with geophysics and college or university students in at least half-time program of study leading to a degree. May vote and hold office.

(A) ☐ ASSOCIATE (Annual dues $20)
Individuals not professionally involved but with an interest in geophysics. May not vote or hold office.

Membership is on a calendar year basis.
Membership applications received *after* October 1 will be made effective as of January 1 of the following year, unless otherwise requested.

DUES RATE (MEMBERS ONLY)
☐ REGULAR MEMBERSHIP Annual dues $20.
(ST) ☐ STUDENT MEMBERSHIP Annual dues $7. College or university student in at least half-time program of study leading to a degree.
(IS) ☐ INDIVIDUAL SUPPORTING MEMBERSHIP Dues plus annual contribution $80 or more.
(SP) ☐ SPOUSE MEMBERSHIP Annual dues $5. Does not include *Eos* subscription. Provide membership number of spouse
(L) ☐ LIFE MEMBERSHIP. A single payment (currently $300) is acceptable in lieu of annual dues. Privileges accorded are those granted to all members . . . and have been changed from time to time.

PUBLICATIONS

MEMBER JOURNAL SUBSCRIPTION RATES – 1983

As an AGU member or associate, you will receive *Eos* each week. You may subscribe to additional publications at very low member rates; simply check those desired. Subscriptions are on a calendar year basis. New members will receive back issues of these journals to the beginning of the year. Remember to add payment to your member dues. Members outside the U.S. must add to the subscription rate the foreign postage surcharge. Additional charge for airmail of printed edition quoted on request. Service does not begin until payment is received. In accepting journals at these rates you are agreeing that the issues will not be used in libraries or reading rooms for at least two years.

Member or Associate	Student	*Foreign Postage Surcharge	Microfiche Edition (Airmail)	Printed Edition	(Select either microfiche or printed edition)
				☐	Eos ($14 of dues is allocated).
					Journal of Geophysical Research is published in three monthly sections:
$42	$19	$18	☐	☐	Space Physics, Section A (blue) Bengt Sonnerup, Editor, 2900 pages anticipated for 1983.
$48	$26	$21	☐	☐	Solid Earth and Planets, Section B (red) Gerald Schubert, Editor, 6600 pages anticipated for 1983.
$38	$21	$18	☐	☐	Oceans and Atmospheres, Section C (green) Ralph Cicerone, Editor, Atmospheric Chemistry and Aeronomy; A.O. Kirwan, Jr., Editor, Oceanography and Boundary Layer Meteorology. Members may subscribe to the full section or to either half of JGR Green published in alternate months for half the subscription price. 3200 pages anticipated for 1983.
$19	$11	$9	☐	☐	Atmospheric (only)
$19	$11	$9	☐	☐	Oceanography (only)
$40	$20	$6	☐	☐	Water Resources Research Published six times a year. Recognized as the leading journal in the water sciences (containing both natural and social sciences). Jared Cohon and Stephen J. Burges, Coeditors, 1200 pages anticipated for 1983.
$45	$23	$10	☐	☐	Reviews of Geophysics and Space Physics An important addition to each geophysicist's permanent library; Andrew Nagy, Editor, 2300 pages anticipated for 1983.
$22	$20	$6	☐	☐	Geophysical Research Letters Reaches more members than any other AGU publication except EOS; monthly reports of fast moving areas of research. Douglas G. Ton and R. E. Riecker, Coeditors, 1200 pages anticipated for 1983.
$33	$27	$6	☐	☐	Radio Science Published six times a year. Akira Ishimaru, Editor, 1100 pages anticipated for 1983.
$22	$11	$4	☐	☐	Tectonics Published bi-monthly. The newest addition to AGU's family of prestigious journals, Tectonics is devoted to publishing leading papers in the structure and evolution of the terrestrial lithosphere, integrative tectonics, structural geology, and materials science. Editor, John F. Dewey, 600 pages anticipated for 1983.

*Non-U.S. include with payment.

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August 1982

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AGU

Membership Applications Received

Applications for membership have been received from the following individuals. The letter after the name denotes the proposed primary section affiliation; the letter A denotes the Atmospheric Sciences section, which was formerly the Meteorology section.

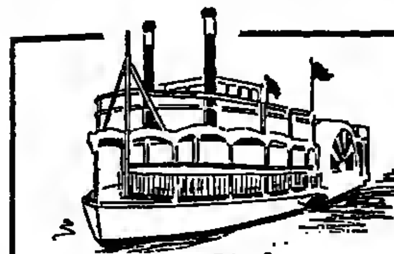
Regular Member

Robert H. Batchelder (O), Francois Brunel (SM), J. Charles Kluse (H), Aubrey L. S. Roe (GP), Keith Stowe (O), S. A. Thorpe (O), James G. Ulwick (SA), Hiroshi Watanabe (V), Yukiro Watanabe (SM).

Student Member

Frederick Chester (T), Richard P. Hooper, Lynn A. McMurdie (M), Avis D. Newell (O), Arnlinn Prugger (S), David M. Sherman (V), Roy A. Swanson (P), Robin George Williams (O), Ross W. Williams (V).

Meetings



Ocean Sciences Meeting

Abstract Deadline: October 19, 1983

New Orleans, Louisiana
Jan. 23–27, 1984

Call for Papers

Abstracts must be received at AGU by October 19, 1983. Late abstracts (1) may be summarily rejected by program chairman or (2) if accepted, will be charged a $25 late fee in addition to the regular publication charge and may not be published in advance of the meeting.

The 1984 Ocean Sciences Meeting of the American Geophysical Union (AGU) will be held January 23–27, 1984, in New Orleans. Housing and registration information will be published in *Eos* and mailed to anyone requesting information on the meeting. Cosponsoring societies are the American Society of Limnology and Oceanography (ASLO); the Acoustical Society of America (ASA); the American Meteorological Society (AMS); the Marine Technology Society (MTS); and the Institute of Electrical and Electronics Engineers Oceanic Engineering Society (OES).

General Regulations

Abstracts may be rejected without consideration of their content if they are not received by the deadline or are not in the proper format. Abstracts may also be rejected if they contain material outside the scope of the meeting or if they contain material already published or presented elsewhere. Only one contributed paper by the same first author will be considered for presentation; additional papers (unless invited) will be automatically rejected.

Abstracts not authored by a member of AGU or of one of the cosponsoring societies must be sponsored by such a member; this includes invited abstracts.

There is a publication charge of $40 ($30 if prepaid) for each abstract. The publication charge is only $20 ($15 if prepaid) if the first author is a student. Both invited and contributed papers are subject to the publication charge. Prepayment of the publication charge saves money. Send a check for $30 ($15 for students) with your abstract. Abstracts must be received at AGU by October 19 to avoid an additional $25 charge.

AGU will acknowledge receipt of all abstracts. Notification of acceptance and scheduling information will be mailed to corresponding authors in early December.

Abstracts

The abstract page is divided into two parts: the abstract itself and the submittal information. Please follow carefully the instructions for each part. Use a carbon ribbon to type the material, and do not exceed the maximum dimensions (11.8 cm by 18 cm) of the abstract. Abstracts that exceed the noted size limitation will be trimmed to conform without regard to content.

The meeting program will be prepared by photographing the abstracts exactly as they are received. Use the model abstract to prepare the final version. Submission of an abstract for an AGU meeting is presumed to carry with it permission for AGU to reproduce the abstract in all editions of *Eos* and in the programs and reports relating to the meeting. It is also presumed to permit the free copying of those abstracts. Although *Eos* is a copyrighted journal, authors are not requested to transfer copyright. Copyright, where it exists, will be reserved by the authors.

Submittal Information

Numbers refer to the items in the submittal-information block on the sample abstract.

1. Title of meeting.
2. Identification (abstracts not authored by a member of AGU or of one of the cosponsoring societies must be sponsored by such a member; this includes invited authors): Type name of society to which any of the authors belong, or if no author is a member, type the name of the society to which the sponsor belongs (indicated by XXXX on the submittal information block) and the sponsor's name.
3. Corresponding address: Give complete address and phone number of author to whom all correspondence (acknowledgment and acceptance letters) should be sent. Abbreviate as much as possible.
4. Discipline to which abstract is submitted (use the following letter abbreviations): A (Atmospheric Sciences); B (Biological Oceanography); C (Chemical Oceanography); G (Geological Oceanography); O (Ocean Technology); P (Physical Oceanography); S (Acoustical Oceanography); X (Other).
5. Type title of special session (if any) to which submittal is made.
6. Indicate your preference for a particular kind of presentation by one of the following letters: O, oral; P, poster. The chairman may assign you to either of these types of presentation in order to fit his or her program plan.
7. Percent of material previously presented or published, and where.
8. Billing information.
   (*a*) Complete billing address if other than the corresponding address (item 3 above).
   (*b*) If purchase order is to be issued, indicate number upon submittal of abstract.
   (*c*) If a student member is the first author, the student publication rate is applicable. Indicate student rate applicable.
   (*d*) If prepaid, enter amount enclosed.
9. Indicate whether paper is C (contributed) or I (invited). If invited, list name of inviter.

Poster Sessions

A large, centrally located meeting room will be set up for poster presentations. Experience from recent AGU meetings and from other scientific societies has shown that a poster presentation, while more demanding of the author, can provide a superb opportunity for comprehensive discussions of research results. If individual papers are deemed by a program chairman to be suitable for this type of presentation, they may be so assigned.

Presenters of poster papers are reminded that a poster exhibit requires careful preparation. Figures and text will be scrutinized in detail, and authors must be prepared to discuss the contents of their papers in depth. Under these conditions, well-prepared figures and concise, logical text are essential.

Program Committee

Meeting Cochairmen John R. Apel, Johns Hopkins University, and Richard T. Barber, Duke University

AMS James J. O'Brien, Florida State University
ASA Robert S. Winokur, ONR
ASLO Mary Jane Perry, University of Washington
MTS Ned A. Ostenso, NOAA

Special Sessions

Warm Core Rings
Air–Sea Interaction in Coastal Regions
Shelf Dynamics; CODE
Optical Dynamics Experiment
Marginal Ice Zone Experiment
California Current
Gulf of Mexico/Caribbean: Biological, Chemical and Physical Oceanography
Southern Oceans: Dynamics, Biomass
Kuroshio
Arctic Ocean: Dynamics, Biology, Acoustics
Seafloor Spreading Centers
El Niño and Climate Variability
El Chichón, Global Climate, Chemistry
Oceans and Atmospheric Chemistry: CO_2, N_2, Freons
Ocean Heat Transport: Climate, Paleoclimate
Acoustic Monitoring: Suspended Particulates, Biology
Acoustic Remote Sensing: Fine Structure, Internal Waves, Mesoscale Features
Acoustic Imaging: Sea Floor, Precision Bathymetry
Acoustic Tomography
Large Scale Ocean Observing Systems
SAR Surface Signatures
Ocean Tracers
Radioactive Disposal
Environment and Fisheries Year Class Survival
Zooplankton Behavior
Plankton Growth Rates in Oligotrophic Waters
Below Ground Processes in Wetland Ecosystems
Phytoplankton Responses to Fluctuating Environments
Aquatic Nitrogen Cycles
Interrelation of Optical and Biological Properties
Dynamics of Microaggregates in Oceanic Systems
Organism Growth and Behavior in a Turbulent Fluid
Biology and Physics of the Benthic Boundary Layer
Feeding Ecology of Fishes
Cyanobacteria: What are They Doing?

Sample Abstract

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Technique for the Preparation of Abstracts

F. R. S. T. AUTHOR (School of Oceanography,
  Hydro University, Watertown, Mass.  02172)
S. C. N. D. AUTHOR (USGS, Woods Hole, Mass. 02543)
  (Sponsor:  I. C. Alvin)

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Submittal Information
(See explanation)

1. Ocean Sciences Meeting
2. AGU, ASLO, MTS, OES, AMS or ASA
   or
   XXXX (sponsor's name)
3. (a). Corresponding address:
   S.C.N.D. Author
   MS 123
   USGS
   Woods Hole, MA 02543
   (b). Telephone number
   617-548-1234
4. A (Atmospheric Science)
5. Special Session:
   Deep-Sea Drilling
   (or none)
6. P (Poster)
7. 10% at AGU Spring Meeting
8. (a). Hydro Univ.
   Accounting Dept.
   Admin. Bldg.
   Watertown, MA 02172
   (b). P.O. #5684739
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October 19, 1983
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